IX. *Obſervations on the Manner in which Glaſs is charged with the electric Fluid, and diſcharged.* By Edward Whitaker Gray, *M. D. F. R. S.*

Read January 17, 1788.

DR. FRANKLIN, in various parts of the firſt volume of his Experiments and Obſervations, aſſerts, That the natural quantity of electric fluid in glaſs cannot be increaſed or decreaſed; and that it is impoſſible to add any to one ſurface of a plate or jar, unleſs an equal quantity be, at the ſame time, given out from the other ſurface *. This error has been adopted by ſucceeding electricians; among others, by the late Mr. HENLY, who in one of his laſt Papers, printed in the Philoſophical Tranſactions for the year 1777, has the following words: "According to Dr. FRANKLIN's theory, "the ſame quantity of the electric matter which is thrown "upon one of the ſurfaces of glaſs, in the operation of charg- "ing it, is at the ſame time repelled or driven out from the other "ſurface; and thus one of the ſurfaces becomes charged plus, "the other minus; and that this is really the caſe is, I "think, ſatisfactorily proved, &c. †."

BECCARIA alſo has adopted the ſame opinion, ſaying, "That "a quantity of exceſſive fire cannot be introduced into one

* "The quantity proportioned to glaſs it ſtrongly and obſtinately retains, and "will have neither more nor leſs." Experiments and Obſervations, Vol. I. p. 26. See alſo p. 75. 81. et alibi.

† Philoſophical Tranſactions, Vol. LXVII. p. 100.

"ſurface, but inaſmuch as an equal doſe of natural fire can "quit the other ſurface*."

Theſe aſſertions are, I apprehend, directly contrary to what really happens. Inſtead of which, I believe, we may ſafely aſſert, that glaſs, and every other known ſubſtance, may have its natural quantity of electric fluid either increaſed or diminiſhed to a certain limited degree; which degree bears no proportion to the quantity of matter contained in a body, but is (*cæteris paribus*) in proportion to the extent of its ſurface.

This law, which is, perhaps, without exception, may be conſidered as one of the fundamental laws of electricity, and one upon which many of its principal phænomena depend. At preſent I ſhall only conſider it ſo far as it is the cauſe of what is commonly called the charge of a coated jar.

Suppoſe ſuch a jar inſulated, and connected by its knob to the prime conductor of an electric machine; if then the machine be put in action, a certain quantity of electric fluid (agreeable to the above-mentioned law) is added to the natural quantity belonging to the inner ſurface of the jar. After which, if the finger, or any other conducting ſubſtance, be preſented to the outer coating of the jar, a quantity of electric fluid, nearly equal to that thrown in, comes from it. But this departure of electric fluid from the outſide of the jar, cannot be (as Dr. FRANKLIN ſuppoſes it) the cauſe which permits the addition of fluid to the inſide, but is merely the conſequence of the action of that ſuperfluous quantity which was thrown in. And the operator may, if he pleaſes, inſtead of taking electric fluid from the outſide of the jar, take out again (by touching the knob) nearly the whole of what he had

* Treatiſe upon Artificial Electricity. Eng. Tranſ. ſect. 181.

thrown

thrown in, which he could not do if an equal quantity had already gone from the outſide of the jar *.

When the quantity already ſpoken of has been taken from the outſide of the jar (the equilibrium being nearly reſtored) another quantity like the firſt may again be added to the inner ſurface: after which a ſimilar quantity may again be taken from the outſide: thus, by the ſucceſſion of a ſufficient number of the quantities allowed by the before-mentioned law, the jar may, at length, be completely charged.

There are other ways of charging coated glaſs; but if it be allowed, that the charge, in the foregoing inſtance, is produced in the manner I have ſuppoſed, it will not, I think, be diſputed, that all other charges are produced by a ſimilar alternation of ſmall quantities. This, however, will appear more clear from the obſervations I ſhall now make on the manner in which the diſcharge is produced.

When the aſtoniſhing velocity with which the charge of a jar or battery moves through a conſiderable ſpace is conſidered, it may at firſt appear impoſſible, that the diſcharge ſhould be made by the alternate giving and receiving ſuch ſmall quantities as thoſe by which the charge was produced; yet a more ample conſideration of the matter will, I think, ſhew that it cannot poſſibly be brought about any other way.

I preſume it will be granted, that the charge of a jar (in diſcharging) either leaves it all at once, or goes out by the ſame ſmall quantities by which it went in. To ſuppoſe any inter-

* Much diſpute has ariſen among electricians reſpecting the degree of charge which may be given to an inſulated jar; but no one, that I know of, has taken notice of a deception which will happen, if care be not taken that the ſame ſide, by which the jar is attempted to be charged, be firſt touched in trying whether it be charged or not; whereas it is clear, from what has been ſaid, that, if the contrary ſurface be firſt touched, a ſmall charge will, from that very circumſtance, be produced.

mediate manner would neither leſſen the difficulty, nor would it be conſonant to any of the known laws of electricity.

If then the whole charge leave the jar all at once, there muſt be a point of time at which the jar will be without any electric fluid either on one ſide or the other: nay more, ſuppoſe a large jar or battery to be diſcharged by means of a few inches of thin wire, there will then be a point of time at which the whole quantity of electric fluid, which conſtituted the charge, muſt be contained in a piece of wire, weighing only a few grains.

Now, if it be conſidered, that time (like matter) is infinitely diviſible, may we not rather ſuppoſe, that the diſcharge of a jar is nothing more than an inconceivably rapid ſucceſſion of ſuch ſmall quantities as may be ſent off, without cauſing ſuch a deſtruction of the equilibrium as the laws of electricity ſeem not to admit?

That this ſuppoſition is not quite free from objections I readily admit; but before they are permitted to overthrow it, let it be well conſidered, whether they are (upon the whole) as ſtrong as thoſe I have ſtated againſt the oppoſite opinion, which I think may be pronounced to militate not only againſt what has been here mentioned as a fundamental law of electricity, but alſo againſt every known fact.